13th ICCRTS

"C2 for Complex Endeavors"

Trust and Decision Making: An Empirical Platform

Topic(s): Cognitive and Social Issues; Collaborative Technologies for Network-Centric Operations; Organizational issues

Dr. Joseph B. Lyons, Capt David Garcia, Mr. Justin Adams (STUDENT), & Mr. David Ames

POC: Dr. Joseph B. Lyons

Air Force Research Laboratory
2698 G Street, Bldg 190
Wright-Patterson AFB, OH 45433-7604
(937) 255-3771
Joseph.lyons@wpafb.af.mil

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
JUN 2008		**00-00-2008 to 00-00-2008**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Trust and Decision Making: An Empirical Platform	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Air Force Research Laboratory,2698 G Street, Bldg 190,Wright-Patterson AFB,OH,45433-7604**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
13th International Command and Control Research and Technology Symposia (ICCRTS 2008), 17-19 Jun 2008, Seattle, WA

14. ABSTRACT
The trust literature emphasizes trust in automation (Lee & See, 2004), thus neglecting the interpersonal aspects of how distributed personnel develop trust. Interpersonal trust represents the willingness of individuals to accept vulnerabilities from the actions of others (Mayer, et al., 1995). Vulnerability is critical aspect of trust research, yet few studies have manipulated vulnerability. Non-verbal cues may have an influence on the trust process (Wicks, et al., 1999), suggesting that features of collaborative tools may influence how individuals build trust. The present study will implement a 3x4 mixed design. Participants will select a convoy route based on: 1) graphical displays of enemy zones and historical Improvised Explosive Device (IED) occurrences; 2) route parameters (e.g., fuel required); and 3) information from a local expert. Vulnerability will be manipulated by altering the frequency of IEDs and the location of ?red forces? to create low, moderate, and high vulnerability conditions (within subjects factor). Information from local experts will be presented via one of four conditions: 1) audio/video with low emotion; 2) audio/video with high emotion; and 3) audio only; and 4) chat (between subjects factor). Findings from this research will support the development of new collaborative tools for the C2 domain.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**11**	

Trust and Decision Making: An Empirical Platform

Dr. Joseph B. Lyons, Capt David Garcia, Mr. Justin Adams, & Mr. David Ames

Abstract

The trust literature emphasizes trust in automation (Lee & See, 2004), thus neglecting the interpersonal aspects of how distributed personnel develop trust. Interpersonal trust represents the willingness of individuals to accept vulnerabilities from the actions of others (Mayer, et al., 1995). Vulnerability is critical aspect of trust research, yet few studies have manipulated vulnerability. Non-verbal cues may have an influence on the trust process (Wicks, et al., 1999), suggesting that features of collaborative tools may influence how individuals build trust. The present study will implement a 3x4 mixed design. Participants will select a convoy route based on: 1) graphical displays of enemy zones and historical Improvised Explosive Device (IED) occurrences; 2) route parameters (e.g., fuel required); and 3) information from a local expert. Vulnerability will be manipulated by altering the frequency of IEDs and the location of 'red forces' to create low, moderate, and high vulnerability conditions (within subjects factor). Information from local experts will be presented via one of four conditions: 1) audio/video with low emotion; 2) audio/video with high emotion; and 3) audio only; and 4) chat (between subjects factor). Findings from this research will support the development of new collaborative tools for the C2 domain.

Background

The contemporary military operates in a distributed fashion using technology-mediated communications as a key enabler for many operations. A fundamental attribute of the Network Centric Warfare (NCW) concept is the ability to leverage advanced information systems to facilitate self-synchronization and enhanced battlespace awareness among distributed forces (see Alberts, et al., 2000 for a review). Thus, computer-mediated interactions will be the drivers for collaboration among future soldiers. This is evidenced by the ubiquity of collaborative tools in the military and their inextricable influence in our daily lives. Those who are skeptical of this assertion are encouraged to work a day without email, chat rooms, blogs, wikis, conferencing software, and or file exchange systems! Yet despite their omnipresent presence in our daily lives, researchers still have a great deal to understand about the costs and or benefits of different collaborative tools. The purpose of the present investigation is to discuss trust as a research topic for military researchers and introduce a research platform designed to examine the influence of disparate collaborative tools on trust.

Collaboration

Collaboration involves the cooperative exchange of information of two of more entities, toward a common goal, and the resulting product is a novel idea, action, and or plan (Harwryszkiewycz, 1997). The technology tools that are used in promoting collaboration are typically called 'Groupware' systems. Groupware systems are a burgeoning area for organizations (Kline & McGrath, 1999) as well as the military (Seymour & Cowen, 2006). However, many collaborative tools have not lived up to their expectations, perhaps due to the lack of convergence among software designers, researchers, and users in the collaboration domain (Briggs, 2006). In fact, it is estimated that approximately 80-90% of all information technology (IT) solutions are unable to reach their projected goals and unfortunately for the military, this number is highest for IT in the defense sector (Clegg, et al., 1997). Software designers tend to focus purely on technology solutions without considering the broader social and organizational context within which users of collaborative tools must operate. Researchers have outlined three essential facets of collaboration: technology, social culture, and knowledge (Harwryszkiewycz, 2005), thus suggesting that the collaboration domain involves more than just the technologies through which people collaborate but it also includes the organizational, social, and cognitive context within which work is accomplished.

Communication, cooperation, and coordination are the essential building blocks of collaboration, yet there are many other essential components for an effective collaborative relationship. In order to truly collaborate, individuals must engage in resource sharing toward a common goal and this sharing may create perceived vulnerabilities, as resources (including information) are finite. Researchers have outlined trust as an enabler to collaboration (Hattori & Lapidus, 2004), and this is logical given that individuals may need to accept vulnerability in order to share resources.

Trust

Virtual team arrangements can be positive for the military because they promote flexibility and agility; however, distributed teams suffer from a variety of negative consequences, such as impaired trust development (Jarvenpaa & Leidner, 1999; Muhlfelder, et al., 1999). While trust plays a role in just about every relational exchange, it is also an elusive and complex construct and its underpinnings are not well understood. The human factors literature emphasizes trust in automation (Lee & See, 2004), thus neglecting the interpersonal aspects of how distributed personnel develop trust. However, there are synergies to be

found between theories that drive the trust in automation and interpersonal trust research. Broadly, trust represents the willingness of individuals to accept vulnerabilities from the actions of others (Mayer, et al., 1995). The trust in automation literature has emphasized factors such predictability, dependability, and faith (Lee & See, 2004). These dimensions correspond to factors that promote trust among team members, such as trustworthiness.

Trustworthiness represents attributes of a person that will make them more or less likely to be trusted, such as ability and integrity (Colquitt, et al., 2007). Non-verbal cues may also have an influence on the trust process (Wicks, et al., 1999), suggesting that features of collaborative tools may influence how individuals build trust. Notably, features of collaborative tools that provide information about non-verbal cues such as facial expressions, verbal tone, gestures, etc., may be better for promoting trust because of the increased availability of this relational information. This supplementary information may be especially useful in ad-hoc virtual teams where members have little pre-existing knowledge of their colleagues. In such situations, dispositional factors are likely to play a large role in trust development (Colquitt, et al., 2007; Rotter, 1980), but these dispositional influences may aid or hinder military interactions depending on the individual differences of the personnel. For example, highly neurotic individuals may be less likely to trust others due to perceived differences while highly agreeable people may have more of a tendency to trust others. Yet, there are many times that military personnel will be asked to trust others despite dispositional tendencies and in these situations individuals may need to accept some degree of vulnerability from others.

Vulnerability is critical aspect of trust research, yet few studies have actually manipulated vulnerability in an experimental study on trust. When placed in economic terms, vulnerability represents the catalyst for trust and thus, without vulnerability, trust is irrelevant, "Indeed, trust is unnecessary when gains equal or exceed potential losses, for then the relationship becomes devoid of the risk of net loss" (Parkhe & Miller, 2000). The higher the vulnerability in a given situation, the higher the level of trust required to generate cooperative actions. Trust should therefore be a key enabler in the military, yet the military must overcome the limitations that pervade computer-mediated interactions by identifying features of collaborative tools that facilitate trust development.

Trust and Military Team Performance

Contemporary military doctrine emphasizes distributed operations, networked interactions, and collaboration between distributed operators. Trust

will be a critical enabler of future military operations as individuals are forced to interact, communicate, and base life-threatening decisions on the inputs of distributed personnel. Past research has shown that trust facilitates information sharing (Kimmerle, et al., 2007), promotes team-oriented goals and perspectives (Dirks, 1999), and it reduces the costs associated with monitoring other team members (Aubert, & Kelsey, 2003). These characteristics are relevant for the current and future military operations. Researchers should continue to explore the optimal mix of collaborative tool features that maximize the benefits and reduce the costs of computer-mediated interactions over the course of a team's lifecycle. Past research has shown that over the course of a team's lifecycle, the enablers of trust change. Dispositional factors and perceived similarity between team members drive initial trust perceptions, while indicators of trustworthiness and actual behavior are the basis for trust later on in the team's lifecycle (Levin, et al., 2006). This suggests that collaborative tools features that allow for individuals to share common backgrounds and similarities should promote trust for ad-hoc military teams.

Convoy Leader Study 1

In order to study the effects of different collaborative tool features on trust development, the Air Force Research Laboratory created the Convoy Leader research platform (see Figures 1 & 2). The Convoy Leader research platform is a java-based interactive environment designed to create a decision making scenario for a Convoy Operator. Convoy operations represent one domain of high importance to the military. Improvised Explosive Devices (IEDs) account for approximately 35% of all fatalities in the Iraq War (Iraq Coalition Casualty Count, 2006) suggesting that this is a significant problem for military operations and a viable domain to study trust and decision making. Additionally, IEDs have been given a great deal of attention in the popular press. Using such a high-visibility problem in an experimental scenario will enhance the face validity of the experiment for participants and increase their engagement in the scenario. However, while convoy operations were used to create the context for the present experiment, the goal of this research is to study the basic decision making process rather than to impact military convoy operations.

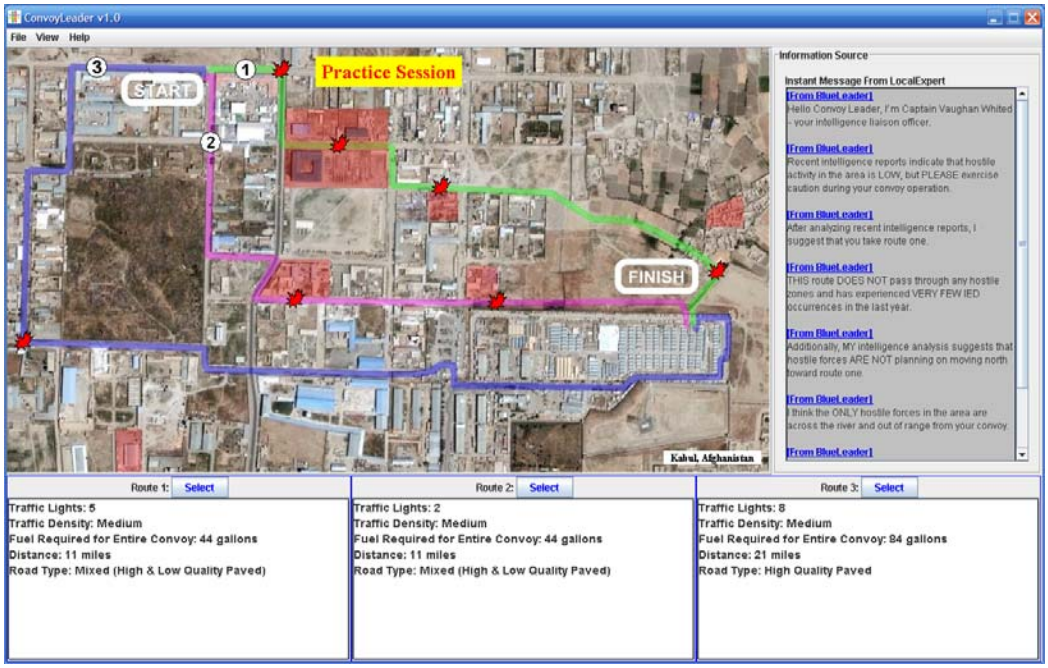

Figure 1. Convoy Leader GUI (Chat Condition)

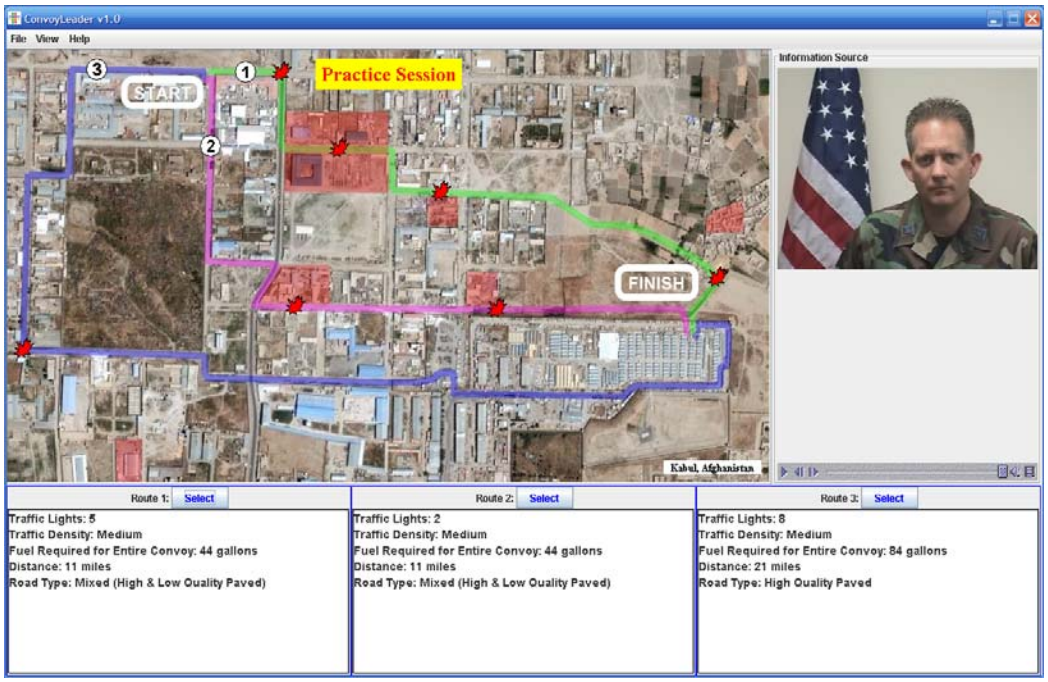

Figure 2. Convoy Leader GUI (Audio + Video Condition)

In the Convoy Leader scenario, participants will be asked to select a transportation route for a convoy operation based on three bits of information. Information will be presented to participants through textual route parameters (e.g., length of route, fuel required, traffic conditions, etc.), a graphical map, and an intelligence analyst. Participants will be provided with a graphical map display showing the routes as well as 'hot spots' representing enemy zones. Information about the history of IEDs in that area will be provided. The IED and enemy zone information (relative to the route being suggested) will be used to manipulate vulnerability to create: low (1 IED + no enemy zone within range); moderate (2 IEDs + 2 zones in close proximity but not overlapping); and high vulnerability (4 IEDs + several proximal zones, one overlapping) conditions. For example, Route 1 (depicted in Figures 1 and 2) should be considered as more vulnerable than Route 3 due to the number of IED occurrences and the proximity of 'hot spots.' This ability to manipulate vulnerability represents a critical aspect of research aiming to study the process of trust development. Without the prospect of vulnerability, trust becomes an irrelevant construct (Parkhe & Miller, 2000).

Participants will also be provided with a suggested route from a local expert. The expert will communicate information to the participants through one of four media styles: 1) audio/video with high emotion; 2) audio/video with low emotion; 3) audio only; and 4) text only (i.e., instant messenger). The media type will manipulate different features of common collaborative tools such as text, video presentation, and audio features. This list of collaborative tool features is not exhaustive as others have done more comprehensive reviews of features of collaborative tools (see Bolstad & Endsley, 2005; Warner, et al., 2005). While there are several different types of collaborative tools, the present research will evaluate whether chat tools, audio-only tools, and audio-video tools differ in their ability to promote trust among users. This basic list corresponds with recent taxonomies that discuss videoconference, audioconference, and computer-mediated communications (i.e., text-based applications; see Wainfan & Davis, 2004).

The present research will extend previous studies by exploring differences between collaborative tools under various levels of vulnerability as well as varying levels of emotionality (for the audio-video condition). The level of emotional expression was manipulated to create high and low emotion conditions for the audio-video condition. Facial expressions, body gestures, and vocal variability were varied according to past research that has successfully manipulated the emotional (i.e., charismatic) aspects of different leadership styles (Lyons & Schneider, under review). Past researchers have speculated that certain

collaborative tools are superior to others because of the degree to which the tools support the recognition of non-verbal cues and emotions. The present research will provide a preliminary test of these assumptions under controlled laboratory conditions. Non-verbal cues are especially relevant in the study of trust development across distributed workspaces because computer-mediated interactions may be more task-focused in nature and thus already have inherent limitations in the amount of non-verbal exchanges (Wainfan & Davis, 2004).

The best mix of collaborative tools may depend on the types of tasks that team members are required to perform. In fact, the proper matching of task demands and collaborative tool capabilities may be the key to effective distributed team performance (Bell & Kozlowski, 2002). The current task involves a decision making activity where participants must assimilate various bits of information and make a course selection. Convoy Leader utilizes a decision making scenario because it has high cognitive complexity and has high demands on collaboration with other people (i.e., the intelligence analyst). Given the high cognitive complexity and the need for collaboration, the Convoy Leader research platform represents a good domain to study the effects of different collaborative tool types on trust development.

Metrics

The value of any research platform is dependent upon its ability to capture meaningful data. The Convoy Leader platform measures both subjective and objective variables related to decision making and trust. Subjective trust measures will be administered along with other psychological assessments. Notable objective metrics include whether or not a participant selects the route suggested by the intelligence analyst and the amount of time it takes to select a convoy route. The former can be used an index of objective trust (i.e., did the participants do what the analyst suggested that they do?). Researchers can then explore the convergence between objective and subjective trust indicators. If these measures were found to converge it would further the psychological literature on trust development and help to validate trust metrics.

Implications for Military Research

The collaboration literature is in need of better theoretical models to guide the development of novel collaborative tools (Briggs, 2006; Kline & McGrath, 1999). This need should resonate with military researchers given the pervading nature of net-centric and distributed operations that represent the future of the military. Military personnel are often required to interact, make decisions, and

place their lives on the line based on inputs from people they may have never met nor will ever meet. Thus, military researchers should continue to explore how to best support these virtual interactions using existing and future platforms. Furthermore, researchers should identify what elements constitute a trusted exchange between military personnel, and if these elements are technological in nature, then military leaders need to understand how to maximize the benefits and minimize the costs associated with different IT solutions. The first step in this regard is to develop a valid and productive research platform from which to study the trust process. Convoy Leader represents the culmination of these efforts with the hope that some of the underlying processes that drive the trust development process can be revealed.[1]

Conclusion

The trust process is an elusive, yet pervasive aspect of contemporary life. Despite its presence in our daily exchanges, researchers know little about the factors that promote trust in distributed teams. The Convoy Leader research platform developed by the Air Force Research Laboratory is one mechanism to continue the path of discover that will hopefully result in greater understanding among military and academic researchers as to the enablers of trust development in virtual teams.

References

Alberts, D.S., Garstka, J.J., & Stein, F.P. (2000). *Network Centric Warfare: Developing and leveraging information superiority* (2nd Ed). CCRP Publication Series.

Aubert, B.A., & Kelsey, B.L. (2003). Further understanding of trust and performance in virtual teams. *Small Group Research, 34,* 575-618.

Bell, B.S., & Kozlowski, S.W.J. (2002). A typology of virtual teams: Implications for effective leadership. *Group and Organizational Management, 27,* 14-49.

Bolstad, C.A., & Endsley, M.R. (2005). Choosing team collaboration tools: Lessons learned from disaster recovery efforts. *Ergonomics in Design, 13,* 7-14.

[1] Study 1 is expected to be completed by June 2008.

Briggs, R.O. (2006). On theory-driven design and deployment of collaborative systems. *International Journal of Human-Computer Studies, 64*, 573-582.

Clegg, C., Axtell, C., Damodaran, L., Farbey, B., Hull, R., Lloyd-Jones, R., Nicholls, J., Sells, R., & Tomlinson, C. (1997). Information technology: A study of performance and the role of human and organizational factors. *Ergonomics, 40*, 851-871.

Colquitt, J.A., Scott, B.A., LePine, J.A. (2007). Trust, trustworthiness, and trust propensity: A meta-analytic test of their unique relationships with risk taking and job performance. *Journal of Applied Psychology, 92*, 909-927.

Dirks, K. T. (1999). The effects of interpersonal trust on work group performance. *Journal of Applied Psychology, 84*, 445-455.

Hattori, R.A., & Lapidus, T. (2004). Collaboration, trust, and innovative change. *Journal of Change Management, 4*, 97-104.

Hawryszkiewycz, I. (1997). *Designing the networked enterprise.* Boston, MA: Artech House.

Harwryszkiewycz, I.T. (2005). A metamodel for modeling collaborative systems. Journal of Computer Information Systems, *45*(3), 63-72.

Iraq Coalition Casualty Count. (2006). Retrieved February 4, 2007, from http://icasualties.org/oif/IED.aspx.

Kimmerle, J., Cress, U., & Hesse, F.W. (2007). An interactional perspective on group awareness: Alleviating the information-exchange dilemma (for everybody?). *International Journal of Human-Computer Studies, 65*, 899-910.

Kline, T.J.B. & McGrath, J. (1999). A review of the groupware literature: Theories, methodologies, and a research agenda. *Canadian Psychology, 40*, 265-271.

Lee, J. D., & See, A. (2004). Trust in Automation: Designing for Appropriate Reliance. *Human Factors, 46*, 50-80.

Levin, D. Z., Whitener, E. M., & Cross, R. (2006). Perceived trustworthiness of knowledge sources: The moderating impact of relationship length. *Journal of Applied Psychology, 91*, 1163-1171.

Lyons, J.B., & Schneider, T.R. (under review). The effects of leadership style on stress outcomes. *Leadership Quarterly*.

Mayer, R.C., Davis, J.H., & Schoorman, F.D. (1995). An integration model of organizational trust. *Academy of Management Review, 20*, 709-734.

Muhlfelder, M., Klein, U., Simon, S., & Luczak, H. (1999). Teams without trust? Investigations in the influence of video-mediated communication on the origin of trust among cooperating persons. *Behaviour & Information Technology, 18*, pp.349-360.

Parkhe, A., Miller, S.R. (2000). The structure of optimal trust: A comment and some extensions. *Academy of Management Review, 25*, 10-11.

Rotter, J.B. (1980). Interpersonal trust, trustworthiness, and gullibility. *American Psychologist, 35*, 1-7.

Seymour, G.E., & Cowen, M.B. (2006). A review of team collaboration tools used by in the military and government. Technical report delivered to the Office of Naval Research (ONR). San Diego, CA: SPAWAR Systems Center.

Wainfan, L., & Davis, P. (2004). Challenges in virtual collaboration: Videoconferencing, audioconferencing, and computer-Mediated communications (Research Report). Santa Monica, CA: RAND Corporation.

Warner, N., Letsky, M., & Cowen, M. (2005). Cognitive model of team collaboration: Macro-cognitive focus. Paper presented at the 49th Annual Meeting of the Human Factors and Ergonomics Society. Orlando, FL.

Wicks, A., Berman, S., Jones, T. (1999). The structure of optimal trust: Moral and strategic implications. *Academy of Management Review, 29*, 99-116.